



Traffic Optimization for Signalized Corridors (TOSCo)

April 23, 2018

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Traffic Optimization for Signalized Corridors (TOSCo)



- Traffic Optimization for Signalized Corridors (TOSCo) system employs data transmitted via wireless communications from Roadside Units (RSU) to connected vehicles to optimize vehicle fuel economy, emissions reduction and traffic mobility along a signalized corridor that is equipped to provide specific information required for the TOSCo system to operate
- The application, hosted on-board a vehicle, collects Signal Phase and Timing (SPaT), intersection geometry (SAE J2735 MAP Data Message, or MAP) and essential information contained in a Roadside Safety Message (RSM) using V2I communications as well as data from nearby vehicles using Vehicle-to-Vehicle (V2V) communications
- Upon receiving the messages, the application performs calculations to determine the vehicle's optimal speed to pass through one or more traffic signals on a green light or to decelerate to a stop and subsequently launch in the most performance-optimized manner
- This information is then sent to longitudinal vehicle control capabilities in the host vehicle to support partial automation.

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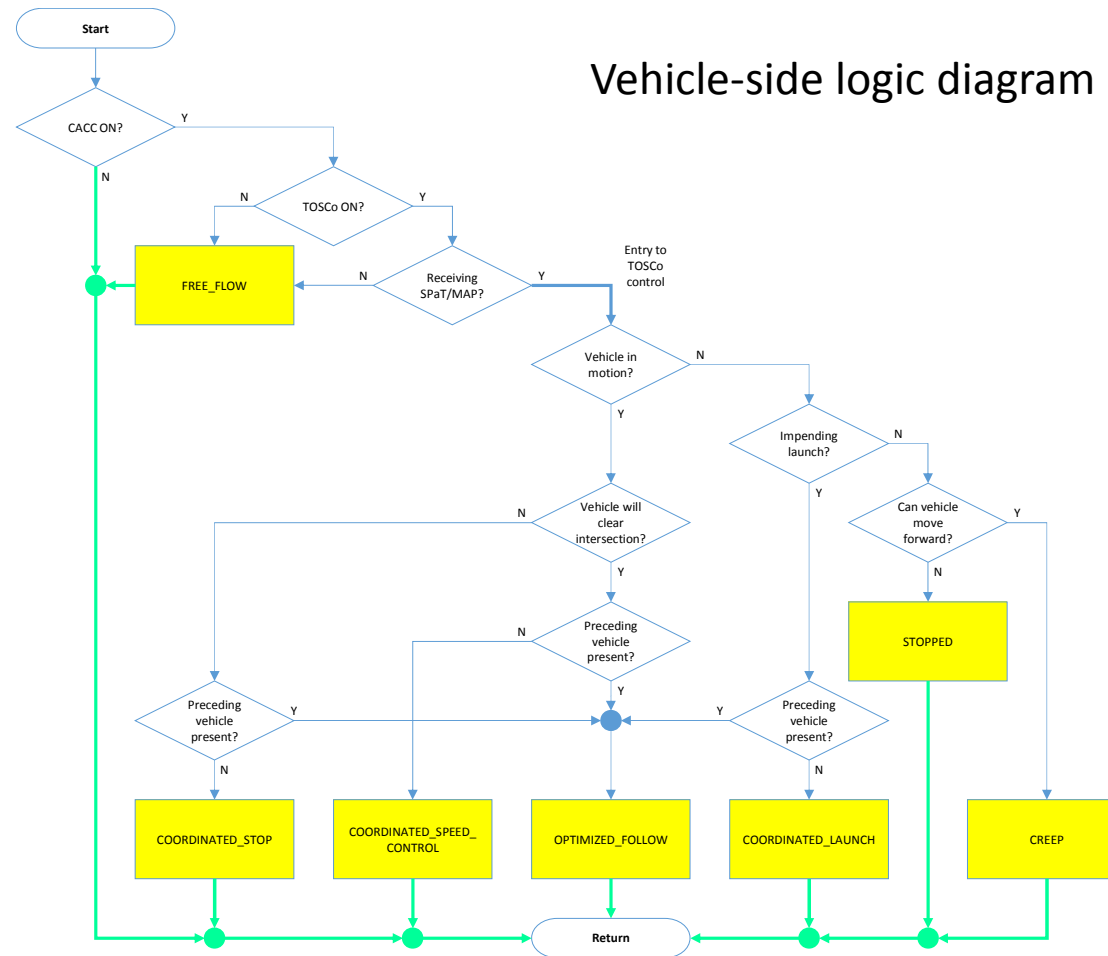
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Vehicle-side logic diagram

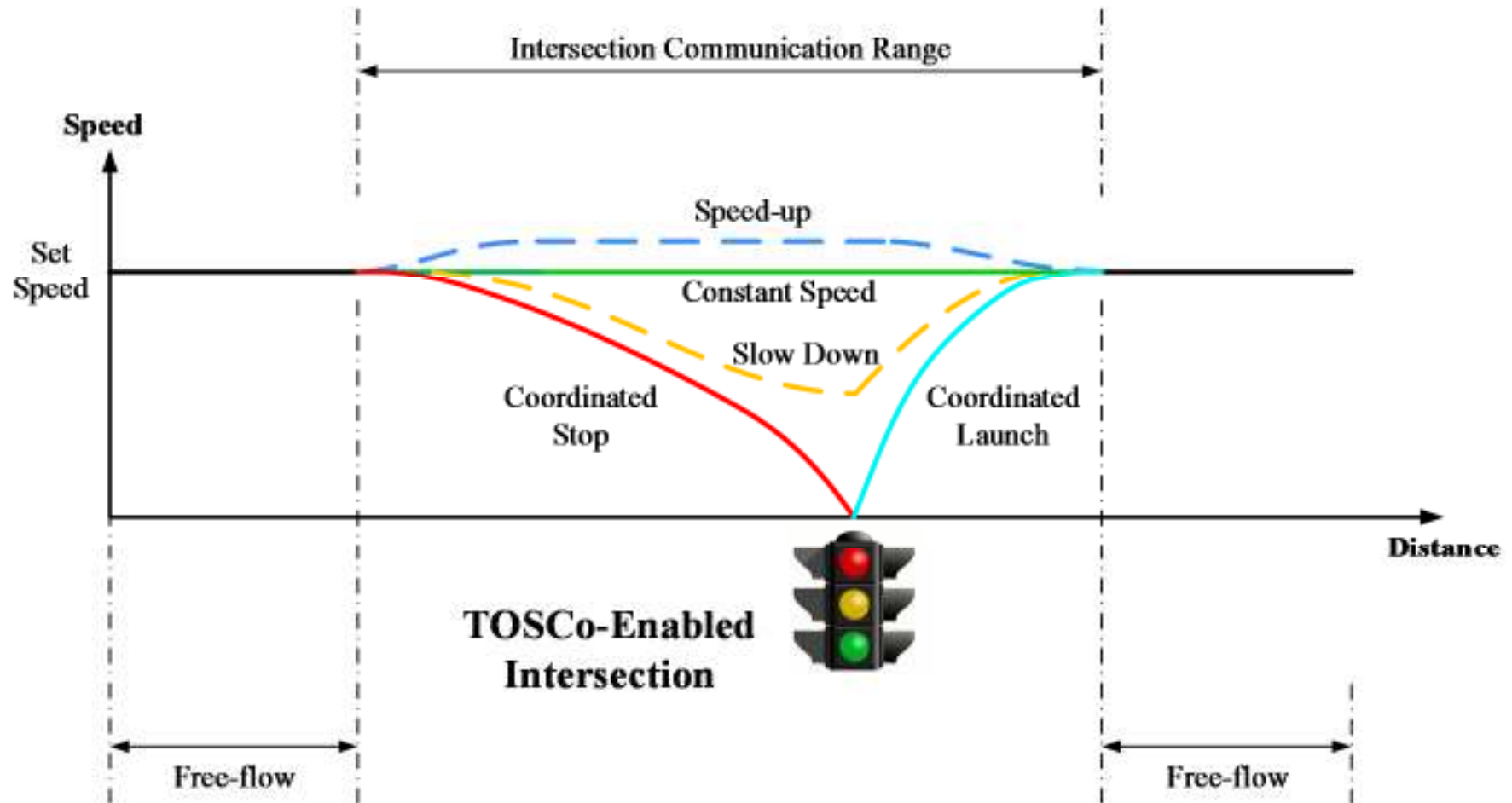


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TOSCo Traffic Scenarios



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TOSCo Operating Modes

FREE_FLOW

- Applies to all vehicles in a string
- Vehicles operate in speed/gap control under CACC if TOSCo-equipped vehicles are currently not receiving SPaT and MAP messages
- Maps to Traffic Scenario #6

COORDINATED_SPEED_CONTROL

- Applies to Lead Vehicle in a string
- Lead Vehicle employs SPaT / MAP / RSM message content to plan a speed profile that allows it to pass through intersection by adjusting CACC set speed to achieve optimization objectives
- One of three possible speed profiles may be employed, depending on existing circumstances:
 - 1) slow down, maps to Traffic Scenario #1
 - 2) speed up, maps to Traffic Scenario #2
 - 3) maintain current speed, maps to Traffic Scenario #3

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TOSCo Operating Modes

COORDINATED_STOP

- Applies to Lead Vehicle in a string
- Lead Vehicle employs SPaT / MAP / RSM message content to plan a speed profile that allows it to come to a stop at the stop bar or end of a queue while meeting optimization objectives
- Maps to Traffic Scenario #4

STOPPED

- Applies to all vehicles in a string
- TOSCo-equipped vehicle is stopped at the stop bar or in a queue

CREEP

- Applies to members of a string (preceding vehicle present)
- TOSCo-equipped vehicle is allowed to creep forward toward the stop bar to fill gaps left by vehicles that vacated lane during red phase
 - Example: Vehicle in right lane making a permissible right turn during a red phase

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TOSCo Operating Modes

COORDINATED_LAUNCH

- Applies to Lead Vehicle in a string
- On-board system checks driver's readiness for launch
 - Checks whether driver has applied the brakes
 - System prompts the driver to release the brakes if applied
- System notifies driver of impending launch
 - Driver must respond to indicate readiness for launch otherwise the vehicle will not move
 - Applicable to all vehicles in the queue
- Lead Vehicle broadcasts a coordinated launch message as it launches upon transition to green phase
- Members of string wait for a Coordinated Launch message and launch upon reception of the message under OPTIMIZED_FOLLOW mode
- Maps to Traffic Scenario #5

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TOSCo Operating Modes

OPTIMIZED_FOLLOW

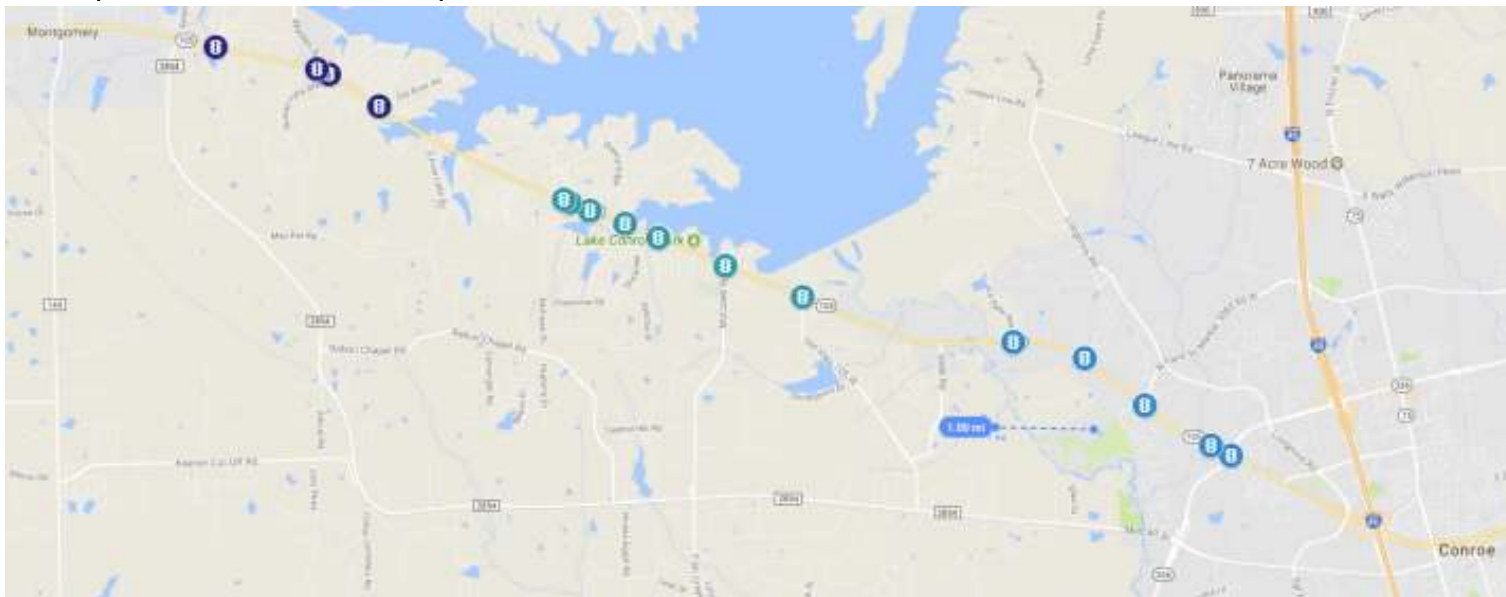
- Applies to members of a string
- TOSCo-equipped vehicles operate predominately as a member of a string under CACC speed and gap control
 - Continually receives SPaT / MAP / RSM messages to calculate optimized speed profile
 - May cause it to leave string and become lead vehicle in a new string if vehicle determines that remaining in string will cause it to operate outside its range of optimized control
- Vehicle employs information from SPaT / MAP / RSM messages to determine whether it will be able to clear an approaching intersection before the next phase change
 - Vehicle transitions to COORDINATED_STOP as lead vehicle in a newly formed string if it determines it will not clear the intersection in time remaining



Planned TOSCo Corridors

State Highway 105, Conroe, TX

- 15 intersections
- 12 miles
- Speed Limits: 45 – 55 mph



- Source: Google Maps

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Planned TOSCo Corridors

Plymouth Rd, Ann Arbor, MI

- 6 intersections
- 2.2 miles
- Speed limits: 35 – 45 mph



- Source: Google Maps

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